Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Time 1 hour 20 minutes

Paper reference **WCH16/01**

Chemistry

International Advanced Level
UNIT 6: Practical Skills in Chemistry II

You must have:
Scientific calculator, ruler

Total Marks

Instructions

- Use **black** ink or **black** ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*

Information

- The total mark for this paper is 50.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, including your use of grammar, punctuation and spelling.
- A Periodic Table is printed on the back cover of this paper.

Advice

- Read each question carefully before you start to answer it.
- Show all your working in calculations and include units where appropriate.
- Check your answers if you have time at the end.

Turn over ▶

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Answer ALL the questions.

Write your answers in the spaces provided.

1 Compound **X** is a green crystalline solid that contains two cations, one anion and water of crystallisation. Tests were carried out on **X**.

(a) State what can be deduced about **X** from its colour.

(1)

.....

.....

(b) About 2 cm^3 of aqueous sodium hydroxide was added to a few crystals of **X** in a test tube and the mixture warmed gently. A pungent gas was evolved that turned damp red litmus paper blue.

Identify, by name or formula, the **cation** that is indicated by this test.

(1)

.....

(c) A spatula measure of **X** was dissolved in about 20 cm^3 of distilled water to form a green solution **Y**. Portions of **Y** were tested.

Complete the table.

	Test	Observation	Inference	
(i)	1 cm^3 of aqueous barium chloride was added to 5 cm^3 of **Y**	....	As well as the sulfate ion, **two** of the anions that might give the same observation are	**(3)**
(ii)	5 cm^3 of dilute hydrochloric acid was added to the reaction mixture in (c) (i)	....	Sulfate ion is present	**(1)**

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	Test	Observation	Inference	
(iii)	A few drops of sodium hydroxide solution were added to 5 cm^3 of a fresh sample of **Y**	A green precipitate formed that remained unchanged on standing	A cation responsible for the green colour could be	**(1)**
(iv)	Sodium hydroxide solution was added to the mixture from (c) (iii), a little at a time, until there was no further change	The green precipitate dissolved to form a green solution	The **formula** of the ion responsible for the green colour of this solution is	**(1)**
(v)	Hydrogen peroxide solution was added to the green solution from (c) (iv) and the mixture was warmed	The green solution turned yellow	The ion responsible for the yellow colour of the solution is	**(1)**
(vi)	Dilute sulfuric acid was added to the yellow solution from (c) (v)	The yellow solution turned orange	The ion responsible for the orange colour of the solution is	**(1)**

(d) State what can be deduced from the observation in (c) (iii) that the green precipitate does **not** change on standing. Justify your answer.

(2)

.....

.....

.....

.....

.....

(e) Give a possible formula of **X**. Water of crystallisation is not required.

(1)

.....

(Total for Question 1 = 13 marks)

2 Compound **P** is a white crystalline solid. The percentage composition by mass of **P** is carbon 60.87 %, hydrogen 4.35 % and oxygen 34.78 %.

The mass spectrum of **P** has a molecular ion peak at $m / z = 138$.

(a) Determine the molecular formula of **P** using all these data.
You **must** show your working.

(4)

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(b) Samples of **P** are subjected to a series of tests.

- When a spatula measure of **P** is added to a solution of sodium hydrogencarbonate, vigorous effervescence occurs.
- When a spatula measure of **P** is added to a cold dilute solution of acidified potassium manganate(VII), the colour of the solution does **not** change.
- When a spatula measure of **P** is added to a dilute solution of bromine water, the solution turns colourless and a white precipitate forms.
- When a small sample of **P** is ignited, it burns with a very smoky flame.

(i) State what can be deduced about **P** from **all** of these tests.
Justify your answers.

(4)

(ii) Describe how you would ignite the sample of **solid P** to show that it burned with a smoky flame.
You may include a labelled diagram in your answer.

(3)

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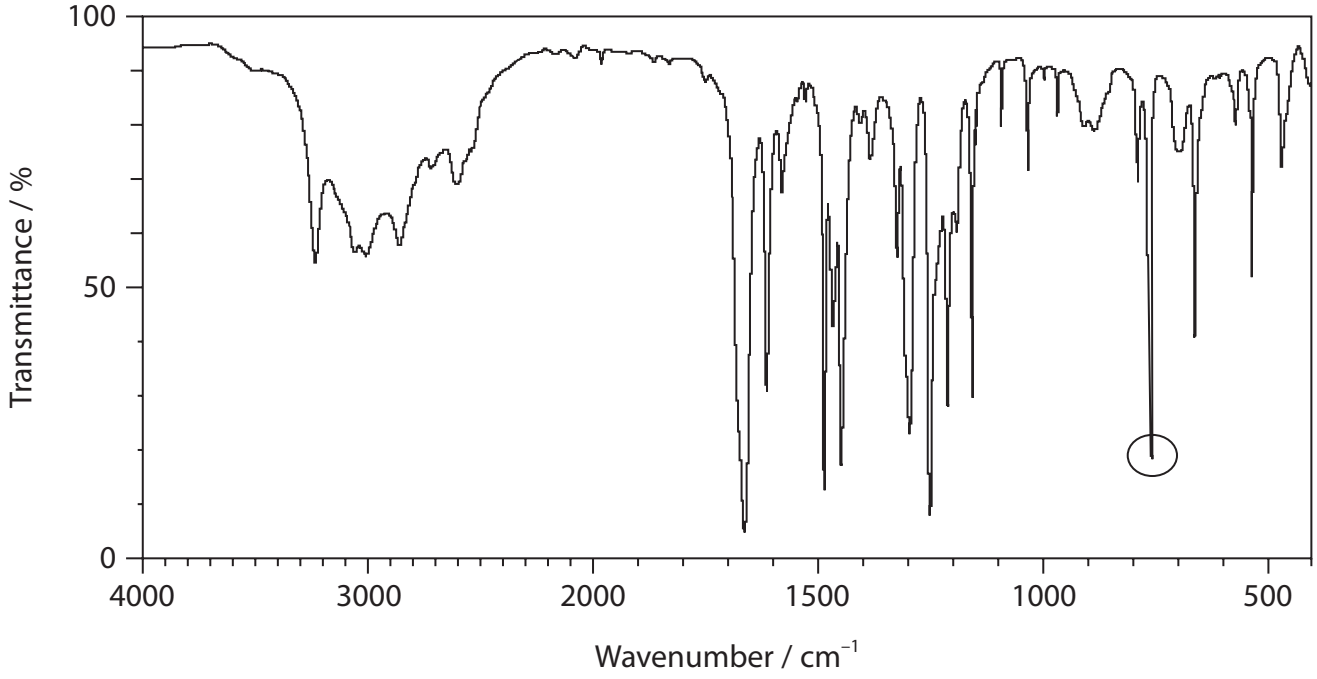
(c) Use the information from (a) and (b) to draw **three** possible structures of compound **P**.

(2)

(d) The infrared spectrum of **P** is shown. One of the peaks has been circled.



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Infrared data for some organic functional groups

Group	Wavenumber range / cm^{-1}
C—H stretching vibrations	
Alkane	2962 – 2853
Alkene	3095 – 3010
Alkyne	3300
Arene	3030
C—H bending vibrations	
Alkane	1485 – 1365
Arene (5 adjacent hydrogen atoms)	750 and 700
Arene (4 adjacent hydrogen atoms)	750
Arene (3 adjacent hydrogen atoms)	780
Arene (2 adjacent hydrogen atoms)	830
Arene (1 isolated hydrogen atom)	880

Explain how the circled peak in the IR spectrum and the table of infrared data may be used to deduce the structure of **P**.

(2)

.....

.....

.....

.....

.....

.....

(Total for Question 2 = 15 marks)

3 Iron(II) ethanedioate is an orange solid which is only slightly soluble in water but dissolves in dilute acid on heating. The formula of the compound is $FeC_2O_4 \cdot x H_2O$, where x is the number of moles of water of crystallisation.

(a) The number of moles of water of crystallisation in $FeC_2O_4 \cdot x H_2O$ may be determined by titration. The procedure is

Step **1** Accurately weigh approximately 2 g of iron(II) ethanedioate into a 250 cm^3 beaker.

Step **2** Add about 100 cm^3 of dilute sulfuric acid to the beaker and heat the mixture until the solid dissolves completely.

Step **3** Use the solution prepared in Step **2** to prepare 250.0 cm^3 of iron(II) ethanedioate solution.

Step **4** Fill a burette with a standard solution of potassium manganate(VII).

Step **5** Transfer a 25.0 cm^3 portion of the iron(II) ethanedioate solution to a conical flask and heat it to about 60 °C.
Titrate the hot solution with the potassium manganate(VII) solution.

Step **6** Repeat Step **5** until concordant results are obtained.

The half-equations for the reactions in the titration are

$$Fe^{2+} \rightarrow Fe^{3+} + e^-$$

$$C_2O_4^{2-} \rightarrow 2CO_2 + 2e^-$$

$$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$$

(i) Describe the procedure used in Step **3**.

(3)

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(ii) State the colour of the solution at the end-point of the titration.

(1)

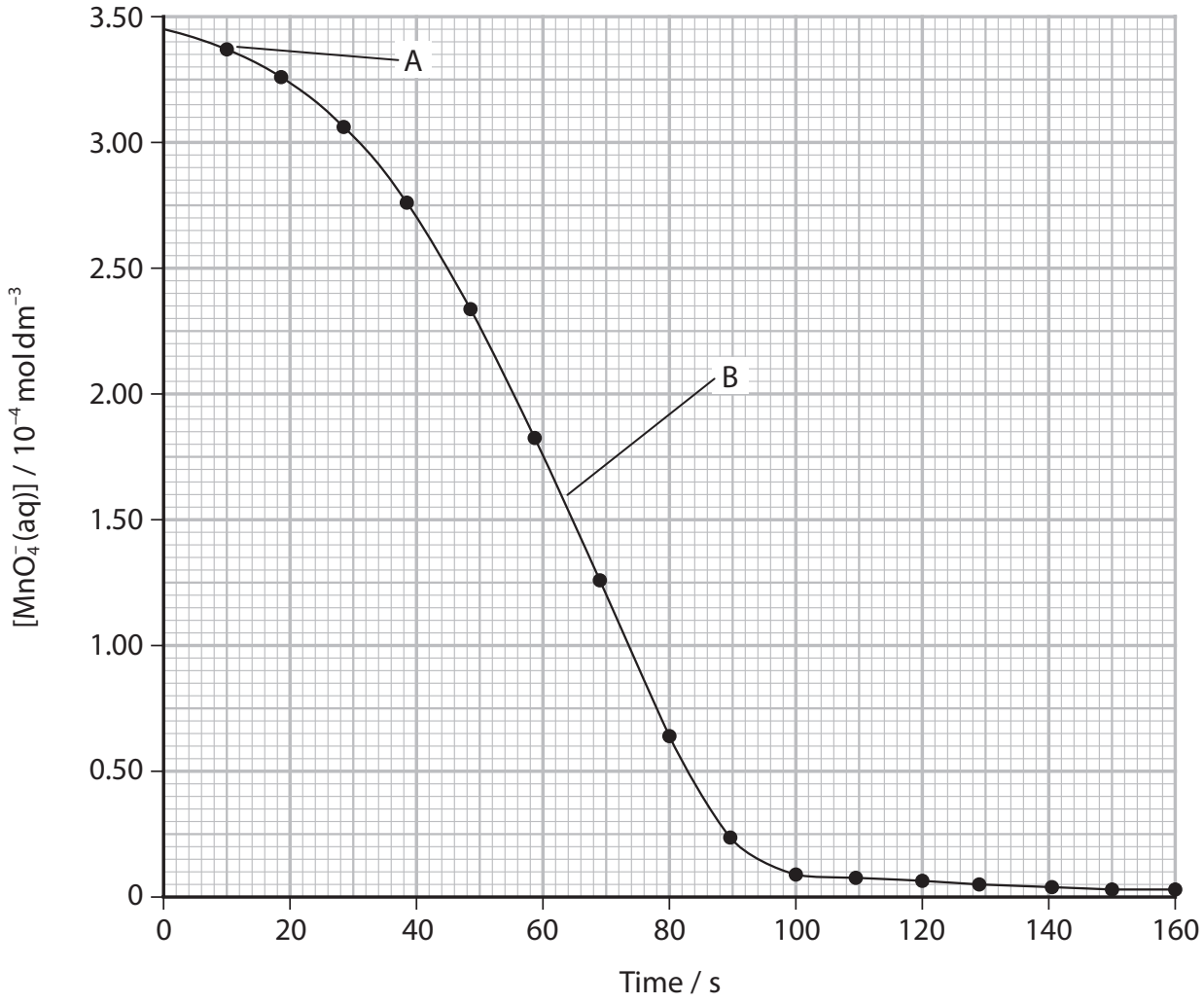
.....

(iii) In an experiment, 2.02 g of iron(II) ethanedioate was used to prepare the solution and potassium manganate(VII) solution of concentration 0.0195 mol dm^{-3} was used in the titration.
The mean titre was 34.25 cm^3.

Calculate the value of x in $FeC_2O_4 \cdot x H_2O$, giving your answer to an appropriate number of significant figures.

(5)

(b) Another experiment followed the progress over time of the reaction of ethanedioate ions with manganate(VII) ions in acid.
The results are shown.



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(i) Describe in outline a **continuous** monitoring method for obtaining results such as these. Practical details are not required but any essential apparatus should be named and the means of obtaining concentrations from the measurement should be stated.

(3)

(ii) Determine the rate of reaction at point **A** and at point **B**. You must show your working on the graph and include units with your answers.

(2)

Rate at point **A**

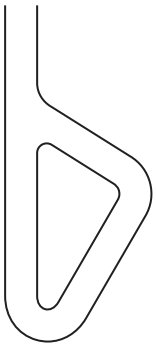
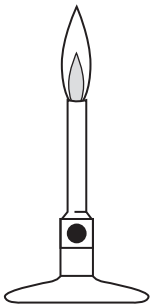
Rate at point **B**

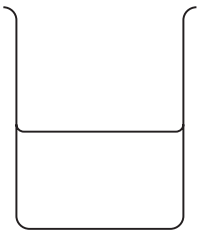
(iii) Explain why the values obtained in (b) (ii) are different from the results of typical rate experiments.

(2)

(Total for Question 3 = 16 marks)

4 The identity and purity of an organic compound may be checked by measuring its melting temperature. Students were asked to determine the melting temperature of samples of a solid organic compound using the apparatus shown.

			
Thiele tube	thermometer	capillary tube	Bunsen burner

		
beaker containing a clear mineral oil	rubber band	solid sample on a watch glass

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(a) Give the steps of the procedure to determine the melting temperature of the solid organic compound, using the apparatus shown.
You may include a diagram in your answer. You do **not** need to show how the apparatus is clamped in position.

(5)

(b) State how the melting temperature of an impure sample of an organic compound would differ from that of the pure compound.

(1)

(Total for Question 4 = 6 marks)

TOTAL FOR PAPER = 50 MARKS

The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8)
							1.0 H hydrogen 1										(18) 4.0 He helium 2
(1)	(2)		Key									(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4		relative atomic mass atomic symbol name atomic (proton) number									10.8 B boron 5	12.0 C carbon 6	14.0 N nitrogen 7	16.0 O oxygen 8	19.0 F fluorine 9	20.2 Ne neon 10
23.0 Na sodium 11	24.3 Mg magnesium 12	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	27.0 Al aluminium 13	28.1 Si silicon 14	31.0 P phosphorus 15	32.1 S sulfur 16	35.5 Cl chlorine 17	39.9 Ar argon 18
39.1 K potassium 19	40.1 Ca calcium 20	45.0 Sc scandium 21	47.9 Ti titanium 22	50.9 V vanadium 23	52.0 Cr chromium 24	54.9 Mn manganese 25	55.8 Fe iron 26	58.9 Co cobalt 27	58.7 Ni nickel 28	63.5 Cu copper 29	65.4 Zn zinc 30	69.7 Ga gallium 31	72.6 Ge germanium 32	74.9 As arsenic 33	79.0 Se selenium 34	79.9 Br bromine 35	83.8 Kr krypton 36
85.5 Rb rubidium 37	87.6 Sr strontium 38	88.9 Y yttrium 39	91.2 Zr zirconium 40	92.9 Nb niobium 41	95.9 Mo molybdenum 42	[98] Tc technetium 43	101.1 Ru ruthenium 44	102.9 Rh rhodium 45	106.4 Pd palladium 46	107.9 Ag silver 47	112.4 Cd cadmium 48	114.8 In indium 49	118.7 Sn tin 50	121.8 Sb antimony 51	127.6 Te tellurium 52	126.9 I iodine 53	131.3 Xe xenon 54
132.9 Cs caesium 55	137.3 Ba barium 56	138.9 La* lanthanum 57	178.5 Hf hafnium 72	180.9 Ta tantalum 73	183.8 W tungsten 74	186.2 Re rhenium 75	190.2 Os osmium 76	192.2 Ir iridium 77	195.1 Pt platinum 78	197.0 Au gold 79	200.6 Hg mercury 80	204.4 Tl thallium 81	207.2 Pb lead 82	209.0 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hassium 108	[268] Mt meitnerium 109	[271] Ds damstadtium 110	[272] Rg roentgenium 111							

Elements with atomic numbers 112-116 have been reported but not fully authenticated

* Lanthanide series

* Actinide series

140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	[147] Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	163 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	[231] Pa protactinium 91	238 U uranium 92	[237] Np neptunium 93	[242] Pu plutonium 94	[243] Am americium 95	[247] Cm curium 96	[245] Bk berkelium 97	[251] Cf californium 98	[254] Es einsteinium 99	[253] Fm fermium 100	[256] Md mendelevium 101	[254] No nobelium 102	[257] Lr lawrencium 103

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